April 29, 2021

BY ELECTRONIC FILING

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
45 L Street NE
Washington, D.C. 20554

RE: Astroscale U.S. Inc. *Ex Parte* Presentation, In the Matter of Mitigation of Orbital Debris in a New Space Age, IB Docket No. 18-313

Dear Ms. Dortch:

On the afternoons of April 27, 28, and 29, 2021, Charity Weeden, Vice President for Global Space Policy, and Luc Riesbeck, Space Policy Analyst, of Astroscale U.S. ("Astroscale") met through videoconference with the following Commission representatives respectively: William Davenport, Chief of Staff and Senior Legal Advisor to Commissioner Starks, Gregory Watson, Policy Advisor to Commissioner Carr, and Erin Boone, Wireless Advisor to Commissioner Simington. The subject of discussion at these meetings was the urgent need for the Commission to move forward with its Further Notice of Proposed Rulemaking regarding the Mitigation of Orbital Debris[1] in light of the ongoing and continuing deployment of hundreds of satellites by a number of satellite operators, and adoption of an aggregate system collision risk assessment when evaluating license applications and modifications for satellite systems. Attached to this letter is the presentation discussed during the meeting.

In the six months since our last comment of November 9, 2020,[2] nearly 1,000 new objects in orbit have been catalogued among hundreds of thousands of lethal non-trackable pieces of debris.[3] Even within March of 2021 alone, two noteworthy debris-generating events occurred,[4] both in an already highly congested region. Yet, the Commission is continuing a 'business-as-usual' approach, approving licenses

[1] *In the Matter of Mitigation of Orbital Debris in a New Space Age*, Report and Order and Further Notice of Proposed Rulemaking, IB Docket 18-313.
[2] Reply Comments of Astroscale U.S. Inc., IB Docket No. 18-313 (filed November 9, 2020) ("Reply Comments of Astroscale").
[3] Source: Celestrak satellite catalog, https://celestrak.com/, accessed April 25, 2021.
[4] Source: "Decommissioned NOAA weather satellite breaks up," *SpaceNews*, March 20, 2021 https://spacenews.com/decommissioned-noaa-weather-satellite-breaks-up/ and Tweet from 18th Space Control Squadron, March 22, 2021. https://twitter.com/18SPCS/status/1374067474111500290

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and modifications that are consequential to the orbital environment, without considering the full, aggregated risk that each system imposes.

It is essential that the Commission's understanding of orbital regimes, and the decisions operators base on that understanding, be shaped by an *accurate* measure of the risk of collision between objects in Earth orbit. This means one license request containing multiple satellites needs to be assessed in its entirety for impact to the orbital environment, including existing space traffic, number of satellites, lifetime, and expected and actual reliability. All FCC-licensed operations should depend on accurate and aggregate measurements as they will positively shape operator behavior and performance in orbit.

The Commission should accurately quantify the risk of collision that an entire system will present over the lifetime of its license. Assessing and authorizing an application containing hundreds or thousands of satellites requires understanding the risk stemming from that entire constellation, not just a single satellite. This means an aggregate risk calculation considering all non-maneuverable satellites in a system must be calculated at the time of application and regularly updated. There is widespread support among commenters that the practice of performing system risk analyses based on the risk assessment of a single satellite of that system, does not holistically or accurately portray the actual risk posed to the orbital environment, and can lead to erroneous conclusions.[5]

As detailed in our previous comments,[6] the Probability of Collision (Pc) measured in the aggregate against trackable objects[7] is a critical, performance-based metric, scaling in large part in relation to the proportion of non-maneuverable (or failed) satellites that are present across an overall system. An aggregate Pc metric for a satellite system can be utilized by the Commission in two ways: 1) to determine

[5] *See* Comments of "SmallSat Operators", IB. Docket No. 18-313 (filed March 21, 2021); Comments of OneWeb, IB Docket No. 18-313 (filed Oct. 9, 2020); Comments of ARCLab and Space Enabled Research Group, IB Docket No. 18-313 (filed Oct. 8, 2020) ("Comments of ARCLab"); Comments of SES Americom, Inc. and O3B Limited., IB Docket No. 18-313 (filed Oct. 9, 2020) ("Comments of SES"); Comments of Viasat, Inc., IB Docket No. 18-313 (filed Oct. 9, 2020) ("Comments of Viasat"); Comments of the Commercial Smallsat Spectrum Management Association, IB Docket No. 18-313 (filed Oct. 9, 2020) ("Comments of CSSMA"); Comments of the Commercial Picosatellite and Nanosatellite Developers Group, IB Docket No. 18-313 (filed Oct. 9, 2020); Comments of the Consortium for the Execution of Rendezvous and Servicing Operations, IB Docket No. 18-313 (filed October 9, 2020); and Comments of Maxar Technologies Inc., IB Docket No. 18-313 (filed Oct. 9, 2020).

[6] *See* Comments of Astroscale U.S. Inc., IB Docket No. 18-313 (filed Oct. 9, 2020) ("Comments of Astroscale"), and Reply Comments of Astroscale U.S. Inc., IB Docket No. 18-313 (filed November 9, 2020) ("Reply Comments of Astroscale").

[7] As the capacity to reliably track and catalogue previously 'Lethal-Non-Trackable' (LNT) objects within the 1-10 cm in diameter range continues to improve, operators and the Commission should be prepared to eventually take the probability of collision with those objects, and the effect of collisions with them, to the environment, into consideration when considering aggregate system collision risk, methods to mitigate debris creation, and overall standards for the safety of space operations.

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if a system entails an adequate orbital debris mitigation plan to minimize the generation of space debris in the proposed system's lifetime and disposal phases, and 2) to regularly monitor and limit overall system risk once a system is in orbit. Because satellite designs can change over time, and unexpected failures of satellites or critical sub-systems can occur at all altitudes, operators and the Commission alike should continually monitor and limit system collision risk as these developments occur.[8]

When complemented by other common-sense safety requirements, such as the reduction of time to disposal at end-of-life, the reliability of disposal, and maneuverability, Pc metrics applied in the aggregate produce a meaningful and comprehensive understanding of the total risk of an applicant's system.[9] Further, the practical effect of a regularly monitored and enforced maximum aggregate Pc (set, for example, at 1/1000) would be a natural cap on the number of failed satellites in a system, not the total allowable number of satellites in a system.

Continued growth, investment, and public benefit generated from the space sector necessitates that collision risk among systems is accurately measured, actively managed, and minimized to ensure the long-term viability of the orbital environment. Risk management, however, is impossible without first establishing a foundation of clear understanding and characterization of that risk. By only calculating the collision risk of a single, non-maneuverable satellite in each system, which could be comprised of hundreds or thousands of satellites, the Commission and operators alike fail in this critical first step of quantifying and tracking risk of the entire space system. Without an accurate understanding, the risk posed by systems to the orbital operations can neither be controlled nor bounded, which is unsustainable for the orbital environment.

Therefore, to balance operational safety and regulatory certainty to ensure that commercial satellite systems are used in the public interest, the Commission should:

[8] *See* Comments of Viasat, Inc. IB Docket No. 18-313 (filed March 23, 2021) (stating "…Ignoring quantifiable risk is to deny the very purpose of orbital debris mitigation plans and practices. Moreover, satisfying predictive collision risk metrics at the application stage should not be the end of an operator's responsibilities to actually implement and deploy its system in a manner that is both safe and responsible.").

[9] *See* Comments of OneWeb at 3 (stating "…[a]ssessing collision risk on a systemwide basis would provide regulators and other key stakeholders a more complete and accurate forecast of the potential debris-generating impacts of large non-geostationary (NGSO) constellations, which would significantly contribute to a safer and more predictable orbital environment.").

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1. **Quantify:** Calculate the aggregate Pc of each system, using a realistic reliability parameter. The Commission must measure the risk that every non-maneuverable satellite will contribute to the space environment when reviewing applications and granting licenses. Measuring total risk of a system, with Pc in the aggregate as a key element of that measurement, is the simplest, most effective performance-based method for mitigating the creation of new orbital debris.

2. **Cap:** Cap the collision risk (Pc) posed by each licensed system. In keeping with historical precedent, and considering a steadily worsening environment, a denser deployment of satellites, and increasing national reliance on space-based assets, we suggest an aggregate Pc limit per system of 1/1000. Operators are afforded ample flexibility in their constellation size while complying with this limit by managing the collision risk of their non-maneuverable satellites (e.g., via orbit selection and cross-sectional area), or by managing the number of non-maneuverable satellites they generate (e.g., via reliability and quality assurance).

3. **Monitor**: Monitor aggregate Pc through frequent required system health reports to the Commission on aggregate Pc for the system. As reliability is difficult to predict and many system design parameters change before and during a license period, risk assessments made during the application phase quickly become obsolete. Whether failure rates are different than expected, the spacecraft design evolves, or other changes that significantly affect aggregate Pc are made, the Commission must maintain up-to-date assessments of aggregate risk to better inform appropriate response and management. This up-to-date reporting allows operators to provide evidence of spaceflight safety through evolving design changes and improvements in reliability of satellites.

4. **Enforce:** Orbital debris mitigation rules are ineffective if they are not enforced. Therefore, the Commission should enforce a cap on aggregate collision risk. If a system's aggregate Pc is shown to exceed the 1/1000 limit during the regular reporting period—whether due to unanticipated failures, slower deorbit times, or other factors—the operator should be responsible for taking prompt, remedial action, and be subject to potential enforcement actions for failure to do so.

We have also evaluated the most prominent current claims against adoption of an aggregate Pc metric. Our findings are as follows:

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Claim: An aggregate Pc metric would arbitrarily limit the size of a constellation.[10]

> **Finding**: False. An application of aggregate Pc would only limit the number of non-maneuverable satellites allowed in orbit at a given time, not the total size of the constellation.

Claim: A per-satellite metric promotes a consistent level of safety across the space operating environment.[11]

> **Finding**: False. Applying a per-satellite metric would allow operators with larger systems to introduce far greater risk to the environment than operators with smaller sized systems. Not only is this inequitable, but it is unsustainable for the space operating environment to allow unbounded risk.

Claim: An aggregate Pc approach would result in different safety standards for otherwise similar satellites, based on total system size.[12]

> **Finding**: True, though the safety profiles of individual satellites are still relevant. Because a system of 1000 satellites poses more risk to the environment than a system of 10 satellites (assuming identical size, orbit, and reliability for all the satellites), an aggregate Pc approach may require the operator of 1000 satellites to target a higher reliability. This ensures safe and equitable access is afforded to all space operators and eliminates scenarios where large operators are licensed to introduce substantially more risk to the environment than others simply because they apply to launch more satellites.

As Earth orbits become home to increasing numbers of active satellites and debris objects, operators and the Commission must consider and utilize a risk assessment framework that considers not only the basic aggregate Pc for a system, but also the impact of collisions on the environment should they occur. For instance, objects with a high surface area and mass, if they experience a breakup or are collided with, would have a greater impact on the orbital environment than collisions between smaller, more compact objects. Similarly, while the Commission assumes maneuverable spacecraft pose virtually zero risk, such spacecraft do indeed pose quantifiable risk, as no maneuver is perfect and risk-free. In the long term, assessing these additional considerations would provide an even greater holistic measurement and more

[10] *See* Comments of Kuiper Systems LLC, IB Docket No. 18-313 (filed October 9, 2020), at 4.
[11] *See* Further Comments of Space Exploration Technologies Corp., IB Docket No. 18-313 (filed October 9, 2020), at 4.
[12] Ibid., *at ii.*

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control of risk for space operations. However, they are difficult to enact without the Commission first *implementing standards for measuring system risk through an aggregate Pc, as a starting point.* Due to the urgency of the situation, aggregate Pc should be the method used to calculate risk of systems on orbit today and should be reassessed and updated regularly to allow future additional risk measurements and metrics for impact to be incorporated as they are vetted and debated.[13]

We urge the Commission to proceed quickly with the Further Notice of Proposed Rulemaking and, critically, adopt an aggregate Pc approach to measuring risk of systems as outlined here and in Astroscale's comments submitted in this proceeding.

Sincerely,

/s/ Charity Weeden

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[13] *See, e.g.* , Comments of the Astrodynamics, Space Robotics, and Controls Laboratory (ARCLAB) and Space Enabled Research Group, IB 18-313, at 3 ("Treating probability of collision alone as a proxy for collision risk ignores the fact that a collision between two small satellites at an altitude of 350 km and a collision between two large satellites at a higher altitude are likely to have different effects on the space environment, even if the probabilities of collision are precisely equal to one another.").

ATTACHMENT

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Aggregate Risk Metrics

Astroscale U.S.

Our Vision

Safe and sustainable development of space, for the benefit of future generations.

Our Mission

Develop innovative technologies, advance business cases, and inform international policies that reduce orbital debris and support long-term, sustainable use of space.

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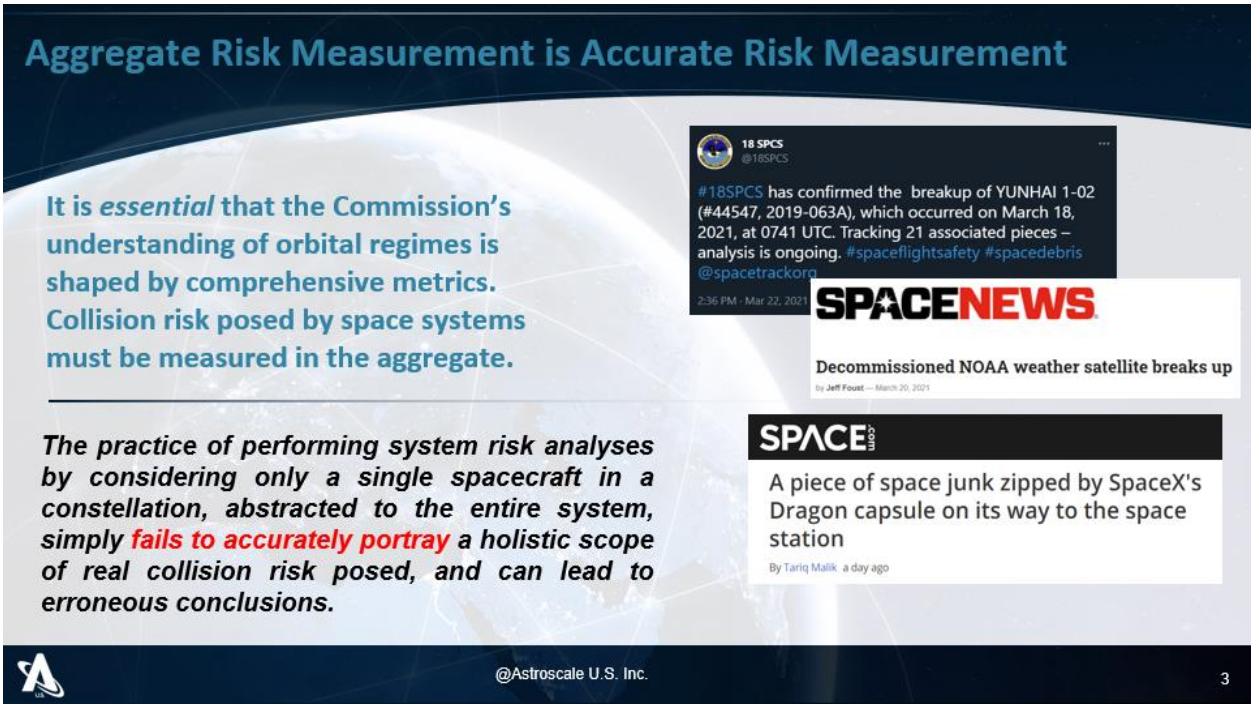

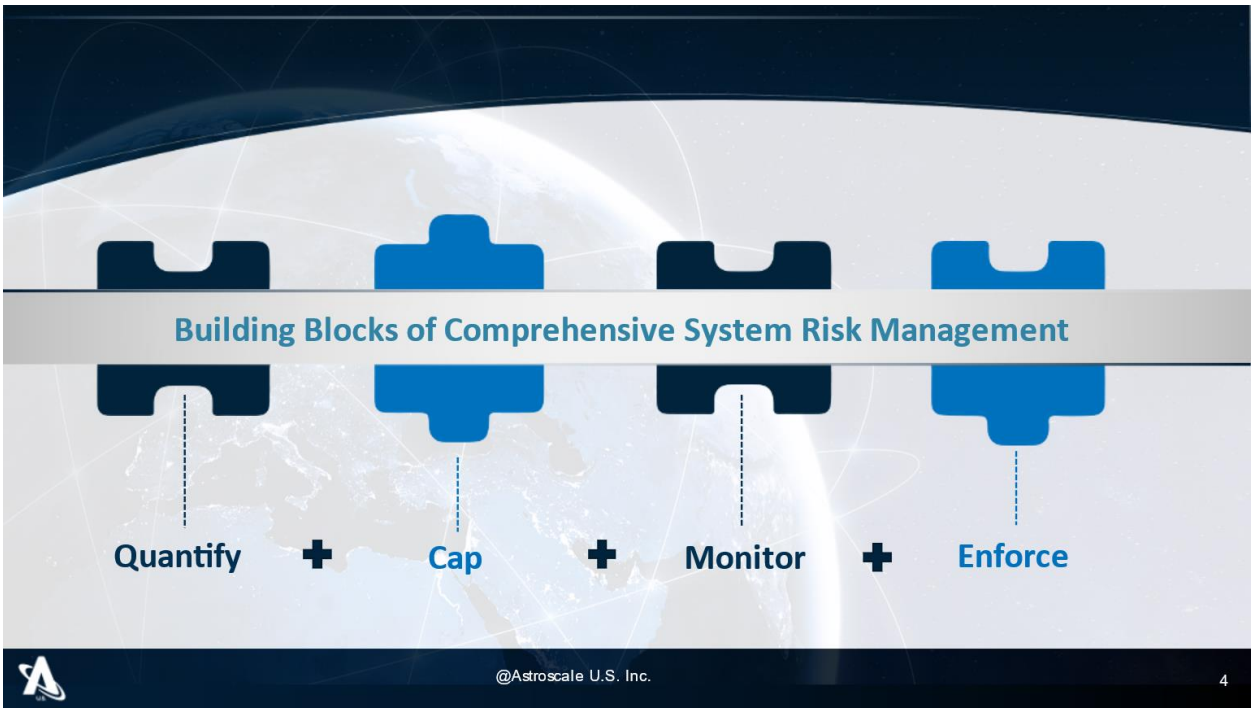

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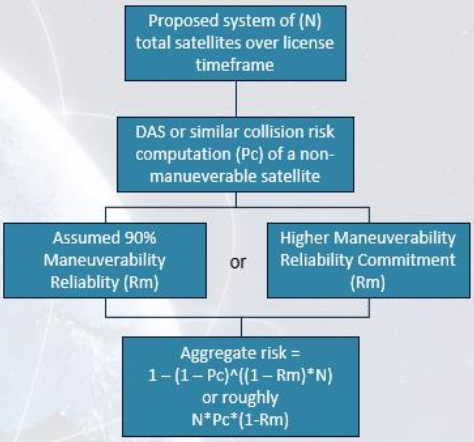
Quantify

The Commission must measure the total risk that every non-maneuverable satellite in a system will collectively contribute to the space environment when reviewing applications and granting licenses to operate.



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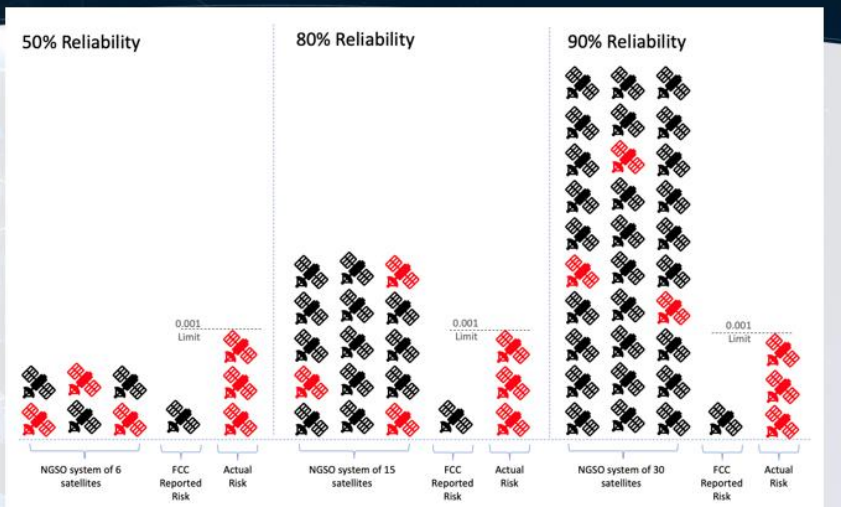
Cap

An aggregate Pc limit of 1/1000 caps the proportion of *failed satellites* in a system, which affords operators flexibility in their constellation size.

Operators have a range of options to adhere to a 1/1000 aggregate Pc limit.



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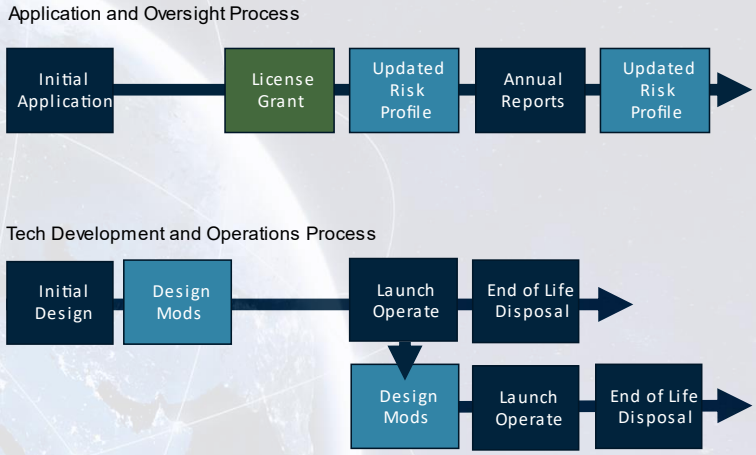
Monitor

The Commission should regularly monitor the aggregate Pc of licensed systems through frequent real-time reporting, or system "health checks."

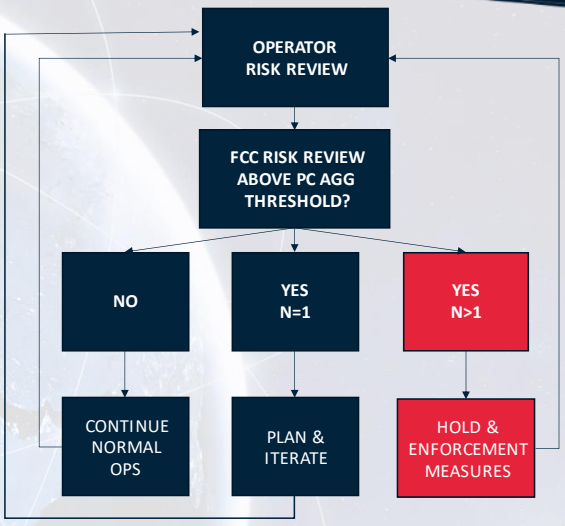
Operators should have the opportunity to take advantage of improvements to their system Pc levels through design changes or deorbit of high-risk satellites.



Enforce

If a system's aggregate collision risk exceeds the limit, the operator should take remedial action.

Repeated violations of the aggregate risk limit should result in Commission enforcement measures, in accordance with its duty to serve the public interest.



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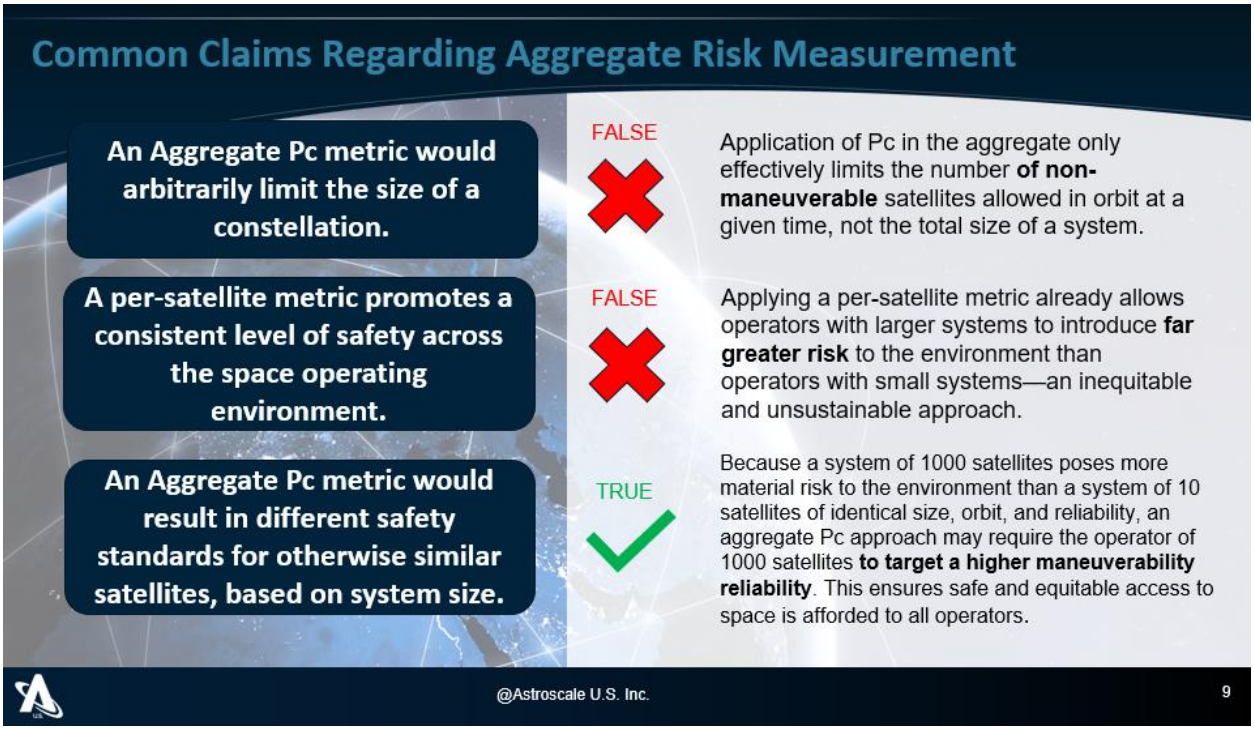

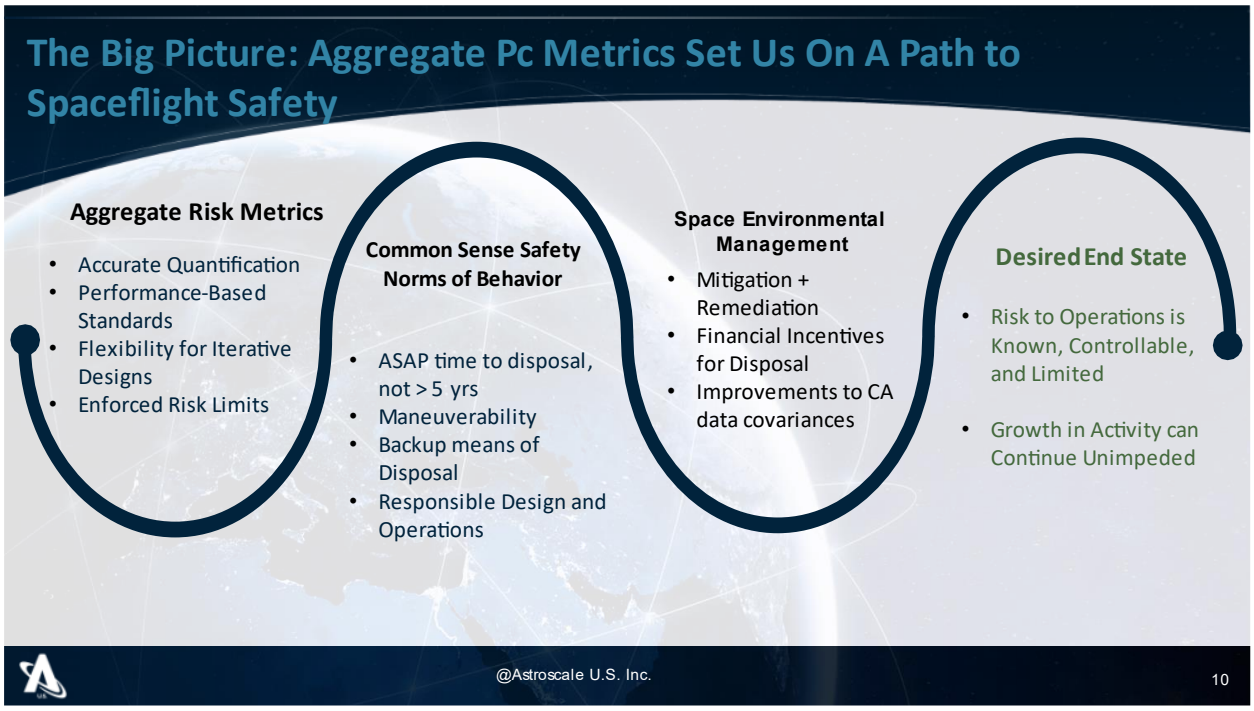

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